APPENDIX 13B

Aircraft Impact Frequency

AIRCRAFT IMPACT FREQUENCY

An identified potential hazard associated with the Airport Fuel Tank Farm which could result in 100% instantaneous tank failure is an aircraft impact with the facility. In the event that an aircraft crashed onto the tank farm, the number of tanks affected would depend on the dimensions of the aircraft, the impact point and whether the aircraft had significant horizontal momentum at the time of impact. The types of aircraft using Hong Kong International Airport include large passenger jets such as the Boeing 747, 777, and the Airbus A340. These aircraft have a typical wing span of 65m and a length of 73m. The next generation of aircraft, which are likely to be using the airport in 2016, will be bigger; the Airbus A380 having a wing span of 73m and a length of 73m. The area of destruction generally assumed in aviation risk assessments is ~ 1 hectare (100mx100m). On this basis, it would be expected that between one and four adjacent tanks will be affected by the immediate impact. The effect on the tanks will depend upon the impact, with catastrophic (instantaneous) failure likely for a tank directly impacted by the fuselage but lesser damage possible for tanks impacted by the wings. A direct impact by one of the engines may well lead to a major hole in a tank, but not an instantaneous rupture. It is also expected that an aircraft impact will result directly in ignition of the instantaneous tank failure.

The main potential aircraft impact hazard to the AFTF comes from the volume of aircraft activity from Hong Kong International Airport, which is located approximately 2km North of the tank farm. The chances of an aircraft crashing from flight at a given location in the vicinity of an airport, depends on the lateral orientation and displacement of the location from the runway centreline. Phillips ([11], [21]) suggests the following expression for the distribution of aircraft crashes from flight in the vicinity of airports:

$$f(R,\theta) = 0.23\exp(-R/5)\exp(-\theta/5)$$

Where, R is the radial distance in kilometres from the runway end, and θ is the angle in degrees between the vector R and the runway centreline. Both R and θ are measured from the threshold at the departure end of the runway for aircraft taking off, and from the threshold at the arrival end of the runway for landing aircraft [22].

The aircraft crash frequency at the Airport Fuel Tank Farm can then be estimated using the following equation:

F = Crash Rate x N x f (R,θ) x Proportion of flights in specified direction x
Proportion of flights using specified runway x Target Area.

Where, N is the number of aircraft movements per year at the airport.

The number of movements is expected to grow from an historical level of 98,423/yr in 1998 to 380,000/yr by 2016. If a third runway is operational by ~ 2040, the number of movements is expected to increase to 700,000/yr. For operational and safety reasons, aircraft usually land and take off into the wind. The prevailing wind directions at the airport mean that about 55% of aircraft movements are from the West.

The North and South runways at Hong Kong International Airport are generally operated in segregated mode, with the South Runway being dedicated for departures and the North Runway dedicated for arrivals (apart from cargo flights and Government Flying Services aircraft which generally land at the South Runway). However, in the longer term, aircraft are likely to be landing and departing from both runways simultaneously, so for the purposes of this study we have assumed that arrivals and departures are both divided equally between the North and South runways [11].

The aircraft crash risk was found to be dominated by landings rather than takeoffs. **Table 13B-1** gives the estimated frequency of aircraft crash onto the Airport Fuel Tank Farm during landings, based on an approach crash frequency of 1.2×10^{-8} per movement per year [11].

The target area of the Airport Fuel Tank Farm has been taken as 7.5×10^{-2} km^2, which is illustrated by the green outline on **Figure 13.14**. This area takes into account both the new extension and existing facilities at the tank farm, and makes ample allowance for the half wingspan of typical aircraft using the Hong Kong Airport.

The risk of an aircraft impact is dominated by landings from the West at the South Runway. The total estimated frequency of aircraft crash onto the AFTF is 1×10^{-7} /yr. It should be noted that the estimates in

Table 13B-1 are based on the distribution suggested by Philips [21] and used in [11] which may be cautious, and that there is also a direct risk to the highway from aircraft impact.

Table 13B-1: The estimated Frequency of Aircraft Crash onto the AFTF

Location	**Direction**	**R (km)**	**Θ (°)**	***f* (R, Θ)**	**Impact Frequency, /yr**		
AIRCRAFT MOVEMENTS					98,000 /yr (1998)	380,000 /yr (2016)	700,000 /yr (2040)
North Runway	From East	2.97	79	1.75×10^{-8}	3.46×10^{-13}	1.34×10^{-12}	2.47×10^{-12}
	From West	3.78	50	4.90×10^{-6}	1.19×10^{-10}	4.61×10^{-10}	8.48×10^{-10}
South Runway	From East	1.40	70	1.45×10^{-7}	2.87×10^{-12}	1.11×10^{-11}	2.05×10^{-11}
	From West	2.93	27	5.78×10^{-4}	1.40×10^{-8}	5.43×10^{-8}	1.00×10^{-7}
TOTAL					1.41×10^{-8}	5.48×10^{-8}	1.01×10^{-7}

Further consideration must be given to the fact that that the site of the tank farm is surrounded by buildings and a hill 68m high on the south east quadrant which provides a shielding that reduces further the chance of a direct hit on the tanks farm by aircraft. In addition, the aircraft would need to fly through a narrow gap between the hill and surrounding building in order to hit the tanks. This can be expected to lead to a substantial reduction in aircraft impact frequency. Although this is difficult to assess in detail, the factor reduction assumed in the Tung Chung Cable Car EIA [11] is >27. We therefore apply a factor of 30 to the aircraft impact frequency based on the same judgement, leading to an overall aircraft impact frequency of 3.4×10^{-9}/yr and an impact frequency per tank of 2.8×10^{-10}/yr (based on the 2040 data).